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REPORT

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General

1. The Research Institute for Vacuum Technique and Technology of Parts (Vyzkumny ustav vakuove techniky a technologie soucastek), /hereafter called "the Institute"/ was located in Prague IX, Hloubetin, Nademlynska Street #600, and was an institute for research and development work in the field of electronics. The management, all the administration departments, and some of the laboratories were located at Nademlynska Street #600. The facilities of the Institute for the production of prototype and samples and some of its other laboratories were located in Prague IX, Hloubetin, at Podebradska Street #184.

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2. The activities of the Institute were conducted in two main branches. The development branch was devoted mainly to the design and manufacture of new, small, special vacuum tubes in small lots, usually a prototype, a few samples or a zero series. (A zero series was a somewhat larger than normal sample-scale production.) The research branch was engaged in research in the field of vacuum tubes and materials for the production of vacuum tubes. In addition to these two main departments, the Institute had a special department engaged in setting up Czechoslovak standards for new vacuum tubes and for materials used in vacuum technique. [1].

3. This Institute was the only one doing research and development work in the field of vacuum technique and vacuum tubes for industrial production. Production in this field was carried out by the Tesla national enterprises. I believe, however, that the Czechoslovak army was also engaged in research on vacuum technique. I believe that the army research in this field was conducted in Tanvald /N 50-44, E 15-187. This research establishment was a department of the VTU (Military Technical Institute).

4. Czechoslovak development in the field of small, special vacuum tubes started in 1946 and 1947 in the development department of the then Tesla Hloubetin National Enterprise, Prague IX, Podebradska #186. VANA, general manager of the Institute as of July 1953, and SLAJS, now a top technician at the Institute, directed that initial development. The Tesla Hloubetin factory was at that time the main Czechoslovak plant for the production of small vacuum tubes and special vacuum tubes. This production was transferred at the end of 1949 and the beginning of 1950 to the Tesla Roznov National Enterprise in Roznov pod Radhostem /N 49-28, E 18-087. The Tesla Hloubetin factory then became a plant for the production of broadcast transmitters and was named Tesla National Enterprise, Julius Fucik Works. Previous to this time, in 1948, the development department of the then Tesla Hloubetin factory was transferred to the factory of the former Prasek firm. (I believe it was a smelting foundry.) It was located at Prague IX, Podebradska # 184. This building was readily adaptable for the research activities of VANA's group, which numbered about five employees at that time. This group was called, for a short time only, Tesla Vyvoj (Tesla Development). In the same year, 1948, Tesla Development was renamed Tesla Elektronik, National Enterprise. It was an independent plant on the same level as other Tesla Enterprises and was directly subordinate to the then Tesla General Management in Prague II, Karlovo Square, # 7, the former location of the administration and commercial department of the Prague branch of the Philips firm.

5. At the end of 1950 a government decree was issued dealing with the creation of research institutes all over Czechoslovakia in all branches of industry and of the economy in general. In conformity with this decree Tesla Elektronik, National Enterprise, was reorganized and renamed Research Institute for Vacuum Technique and Technology of Parts, its present name. Also in conformity with this decree, research institutes were created

   a. from research institutes already existing at the time,

   b. from industrial enterprises, or from their research and development departments and,

   c. from no previous organization, an entirely new institute being created. The Research Institute for Vacuum Technique and Technology of Parts was a typical example of the second type (b).

At that time (end of 1950) the Institute had about 30 employees, most of whom had formerly been employed at the Tesla Hloubetin plant. I do not know to what organization the Institute was subordinate. It may have been subordinate to a central organization for all research in Czechoslovakia if there was such a central organization.

6. At the end of 1950 or at the beginning of 1951 the Institute received another building located in Prague IX at Nademlynska Street # 600. This building formerly belonged to the Tesla Always National Enterprise, which engaged in the production of radio parts. (The Tesla Always National Enterprise was the former private firm Always.)

7. At the beginning of 1953 there were about 60 technicians or trained workers employed with the Institute. In addition, there was an unknown number of laborers. Of the 60 employees about 40 were men and about 20 were women. Thirty employees were in the Podebradska Street section and 30 in the Nademlynska Street section.

8. The salaries of the technicians in the Institute were approximately 15% higher than the salaries of technicians employed in similar positions in the various Tesla production enterprises. This wage policy conformed to the general policy in Czechoslovakia of paying technicians employed in research and development 10 to 20% more than technicians in similar positions working on mass production. This rule did not apply to the administrative employees and laborers. The general manager of the Institute received a salary of about 20,000 crowns monthly. The chief technician in development and research received 8,000 to 10,000 crowns monthly. The chief of the testing laboratory received 9,000 to 10,000 crowns monthly. The chief of the wage department received 8,500 crowns a month.

9. Persons not employed by the Institute had to show an entry permit when entering the Institute area. There were two types of visitors' entry permits: a permanent entry permit for persons visiting the Institute frequently and a special entry permit authorized for one visit only. The entry permits were issued by the employer of the person visiting the Institute and stated the exact purpose of the visit and the person to be contacted. The entry permit had to be approved by the Institute administration. There were guards on duty at the entrances to the Institute who were armed during the night. I do not know whether there was a plant militia in the Institute.

History of Research at the Institute

10. Research in the field of vacuum tubes and the materials needed for their production started in Czechoslovakia in 1948. In this year a chemical laboratory was created within the new Tesla Elektronik National Enterprise located at Podebradska # 184. This laboratory was headed by Ing. JANIK, about 28 years old, chemist, anti-Communist. JANIK alledgedly escaped into Western Germany in the summer of 1950. This laboratory had three employees in 1948 and about six employees at the end of 1952. The plan was to hire more employees in the future. Until the time this laboratory was created the only laboratories in this field were chemical laboratories concerned with problems of mass production which were located in the Tesla Hloubetin, Tesla Vrchlabi /N 50-38, E 15-36/, and Tesla Holesovice (Prague) plants.

11. In 1951 a second laboratory for glass research was created in the Institute. It was located in the Nademlynska Street section of the Institute. Since that time other laboratories must have been created in the Institute but I have no details.

12. Until the end of 1950 the practice was for individual Tesla enterprises to submit their suggestions for research and development directly to the Tesla Elektronik National Enterprise. Starting in 1951, after the Institute under its present name was created, individual Tesla enterprises submitted their suggestions for research and development to the Institute through the Ministry of General Machinery. Both Tesla Electronik and later the Institute sent their specialists directly to individual Tesla enterprises whenever these enterprises requested it. The Institute had only an advisory capacity and in no way acted in an executive capacity in its relation with individual Tesla plants.

Machinery and Equipment at the Institute

13. The development branch of the Institute, located at Podebradska Street, contained the following equipment:

a. Machine for winding grids for small receiver tubes and miniature tubes. The machine was semiautomatic. I do not know its origin. 3.

b. Two machines for winding grids for small receiver tubes, miniature tubes, and subminiature tubes. These machines were manually operated. I do not know the origin of these machines.

c. Two machines for evacuation of vacuum tubes. These machines were used only when the tubes were handled piece by piece. The machines were of Philips design but manufactured in Czechoslovakia at the Institute itself or at the Tesla Roznov plant. The machine consisted of an oil-rotary air pump for creating a partial vacuum. This air pump was connected with a mercury diffusion air pump for making the perfect vacuum. The tubing interconnecting these pumps was mainly of lead glass. The machine was equipped with a holding jog where the vacuum tube to be evacuated was fixed. There was a mercury manometer of the McLloyd type for vacuum measuring.

d. One machine for evacuating gases from the internal tube parts by high-frequency heating. This machine consisted of an oil-rotary air pump, a mercury diffusion air pump, interconnecting tubing of lead glass, an air-pumping bell of silicon glass, a McLloyd manometer, and a high-frequency coil. The origin of this machine was the same as that of the machines listed under (c) above.

e. One automatic machine for evacuating vacuum tubes. Twelve tubes could be handled by this machine at one time at 12 different positions. The machine was equipped with a central air pump which provided a partial vacuum. I do not know what type of pump this was. Each of the 12 different positions had an independent mercury diffusion air pump for the final evacuation. There was a coil for heating installed at each position. This machine came from the Tesla Roznov or Tesla Vrchlabi plant, but it was certainly of foreign origin.

f. One semiautomatic machine for sealing small tubes. This machine was used in the Institute for sealing of all-glass tubes and it could be easily adapted for sealing of miniature tubes. This machine was of foreign origin, obtained by the Institute from the Tesla Roznov or Tesla Vrchlabi plant. There was no automatic or semiautomatic machine in Czechoslovakia for sealing large vacuum tubes. The so-called lathe machine was used for this purpose in the Tesla Vrsovice plant.

g. One high-frequency generator for supplying high-frequency current to the coils installed on the machines listed under (c), (d), and (e). I do not know the origin of the generator.

h. Two machines for sealing vacuum tubes. These machines were manually operated and were of Czechoslovak origin. Each tube passed through four different positions, but only one tube could be processed through each machine at one time.

i. One glass lathe machine for sealing glass tubes or parts of tubes in the large or medium sizes. The Institute used this machine for sealing the largest tubes produced in the Institute (these tubes were still in the category of small tubes by other standards). This machine was of Czechoslovak origin. I think it was a Skoda product.

14. The foreign machines in the Institute (as were all the foreign machines in Czechoslovakia used in this field) were of Netherlands or German design. There were no single-purpose, complicated machines of Czechoslovak manufacture in the vacuum tubes production industry. The first efforts to produce more complicated machines for the production of vacuum tubes in Czechoslovakia were made in 1948 and 1949 by the then Tesla Hloubetin general manager, Ing. Josef SLESINGER. These efforts were directed especially toward the production of semiautomatic grid winding machines, sealing machines, machines for making vacuum, and some special machines for finishing semifinished glass products.

15. The simple machines and equipment made in Czechoslovakia for vacuum tube production were produced in part in the then Tesla Hloubetin plant. I think that the Skoda Works were assigned the production of more complicated machines for vacuum tube production. The technician of an unknown Skoda plant in Prague visited the Tesla Hloubetin plant frequently in 1949 and examined the machines of foreign origin. In the first half of 1950 I saw in the Tesla Hloubetin plant the first semiautomatic grid winding machines of Czechoslovak origin. There was a total of two to four of these machines.

16. The laboratory for glass research in Novomlynska Street was equipped, in addition to the normal laboratory equipment, with two special instruments:

a. One dilatometer for measuring the expansion of glass. I do not know the origin of this instrument. Czechoslovakia started production of its own dilatometers in 1951 or 1952. I do not know which Czechoslovak plant was engaged in this production. I do know that these instruments were produced in Czechoslovakia, as the Tesla Vrsovice plant ordered one or two units of Czechoslovak origin for 1953.

b. One viscosimeter for measuring the viscosity of glass. I do not know the origin of this instrument.

Development of Small Receiver and Special Vacuum Tubes

Small Receiver Tubes

17. The first small vacuum receiver tube developed in Czechoslovakia was the EY 3000. This was a half-wave, indirectly heated rectifier. It was rated at 50 watts anode dissipation, with 800 v. plate supply and 6.3 v. filament supply. This tube was to be used in a new type of amplifier which was in production in the Tesla Karlin (Prague) plant. The tube was developed in 1947 and starting from 1948 about 1,000 were produced annually, first in the Tesla Hloubetin plant and later in the Tesla Roznov plant. I think this tube is still being produced.

18. The second tube developed was the 6F 24. This type was similar to the EF 22 European type. The differences were that the 6F 24 was designed to be used at higher frequencies and to have a higher gain. I do not know the upper frequency limit. It was an all-glass vacuum tube with an aluminum cover. It was designed in 1949 and turned over to the Tesla Vrchlabi plant (in 1949) for mass production.

19. The 6L 24 was a final pentode. Its performance characteristics were similar to those of the EBL 21, a European type. The 6L 24 had a lower noise factor and a higher transconductance than the EBL 21. This tube was an all-glass tube developed in 1950 and put into mass production in the Tesla Vrchlabi plant or in the Tesla Roznov plant; I am not sure where.

Miniature Tubes

20. The first efforts to develop miniature vacuum tubes date from 1947 and 1948. It was planned to produce various types of miniature tubes for use as replacements of the E-type all-glass tubes in newly designed civilian broadcast receivers and for other purposes. These E-type tubes were marked ECH 21, EBL 21, EF 22, and EY 21. I do not know exactly for what purpose these were used but some of them were probably for military use. The development started in 1949, and the miniature tubes were to have similar performance characteristics to the US RCA products. About six to eight types of the US tubes were brought into Czechoslovakia in 1947 and 1948 to serve as models. The first Czechoslovak miniature tube was a full-wave rectifier with indirect heating. This tube was developed before the end of 1949 and its designation was probably 13Y31 /see Annex D, Sketch A/. It achieved about half the performance standard of the US tube and therefore the design was a failure. I believe that some dimensions (the size of the anode, for instance) and tolerances had to be changed later when the tube was put into mass production. The documents dealing with the technology of production, as for example the technique of preparing the insulating material, were not in sufficient detail. The tube was a failure mainly because it was the first miniature developed; the personnel of the then Tesla Elektronik were not sufficiently qualified, and the production equipment was inadequate. However, the personnel and equipment in the Institute have improved since that time. I believe that, if developed in 1953, the 13Y31 type would achieve perhaps 90% of US standards. In the first half of 1951 the Tesla Roznov plant was preparing to put the 13Y31 type tube into mass production. The 13Y31 type was the most simple miniature to develop and produce. Beginning in 1950, more complicated miniatures were developed in the Institute. I have drawn a sketch /Annex D, Sketch B/ showing a miniature developed there during 1950. I cannot remember the designation. The features of this miniature, shown on the sketch, were common to all the miniatures which were to replace the all-glass tubes listed above.

Subminiature Tubes

21. At the end of 1951 or at the beginning of 1952, the Institute planned to develop subminiature vacuum tubes. The first subminiatures I saw in Czechoslovakia were three subminiatures of foreign origin, probably US RCA products. These were in the Tesla Hloubetin plant for testing purposes. I saw a few other subminiatures in the Institute at the end of 1951 which were also foreign products and similar to the three I had seen previously. The tubes were under study in the Institute and I think that it was planned to use them as samples for new Czechoslovak subminiatures. I have drawn a sketch /Annex D, Sketch C/ showing a subminiature that I saw in the Institute. In general the subminiatures were similar to the miniature described above. The features

shown on the sketch were common to all the subminiatures that I saw. The main difference between the miniature I have sketched /Annex D, Sketch B/ and this subminiature was in the base of the tube. The base of the subminiature was a simple, lead-glass plate, circular or oval, not a glass die casting as on the miniature. The base had the prongs (NiFeCu wires) sealed into it. The number of prongs varied. They were 0.35 mm. or thinner in diameter.

Sub-Sub-Miniature Tubes

22. In the first half of 1952 the Institute planned to develop a tube known as the sub-sub-miniature (sub-sub-miniaturni elektronka). The only sub-sub-miniature that I saw in Czechoslovakia was a diode, I believe, shown to me by SLESINGER at the beginning of 1950. This tube was of foreign origin. /This tube is shown on Annex D, Sketch C, Figure B/. I have no other information concerning this tube.

Transmitter Tubes

23. The Institute was engaged in development of small transmitter tubes and special vacuum tubes from the end of 1949. The largest tube in this category was 500 watts (occasionally as high as 1,000 watts). I saw, at the end of 1949, a few foreign tubes being studied at the Institute. It was planned to develop about eight types of small transmitter tubes. They were mainly triodes, indirectly heated, with a tungsten, tungsten-thorium, or oxide cathode. The anode was molybdenum or molybdenum coated with a zircon material (80% zircon, 20% oxide). Occasionally the anode was carbon, nickel, or iron. The grids were molybdenum or tungsten. The glass was mainly molybdenum glass. The base was a die casting of the same glass as the envelope. I do not know the exact purpose for which these tubes were to be used but I believe they were for military purposes, mainly for portable transmitters. One of these tubes was a triode with characteristics of an impulse tube. This triode was apparently destined for radar equipment. I have no further information concerning this tube.

Military Tubes

24. At the end of 1949 the Czechoslovak military authorities approached the Institute with a demand for a design of two types of vacuum tubes: the RV2,4 P800, and the RV12 P3000 (possibly 4000). These types of tubes had been produced for military purposes during World War II, mostly in Germany. Some had also been produced in the Tesla Hloubetin plant. After the war these tubes were stored in military depots and were sold on the civilian market for the use of amateur radio operators. In 1949 the Czechoslovak army took an interest in these tubes and I believe they were taken off the market. In response to the demand of the Czechoslovak military authorities the Institute produced designs of this type tubes in the first half of 1950 and turned them over to the Tesla Hloubetin plant which had to prepare detailed specifications for the mass production of these tubes. It was planned to produce from 10,000 to 20,000 units of these types annually at the Tesla Roznov plant. I do not know whether this mass production has begun.

25. At the end of 1951 or at the beginning of 1952 the Czechoslovak military asked the Institute to produce several types of tubes, some of which were most probably miniature. The army originally planned to produce these in the Tesla Roznov plant. However, the Tesla Roznov plant and the army could not come to an agreement. The Roznov plant claimed that the number of tubes to be produced was too low for its plant, and the army considered that the Roznov plant needed too much time for tooling for mass production.

Development of Picture Tubes, Phototubes, and Projector Lamps

26. The Institute started the development of picture tubes in 1949. German designs kept in the Tesla Hloubetin plant since World War II, along with models of unknown foreign origin, served as a basis of this development. Later on, a small number of these tubes was produced at the Institute. The picture tubes were not produced anywhere else in Czechoslovakia. Originally these tubes were for use in oscillographs and later they were used for television equipment.

27. The development of the first Czechoslovak phototube started in the Institute in the second half of 1949. Most likely this first type of tube was to be used for the sound channel of movie projectors. This development was based on a Philips design which had been kept in the Tesla Hloubetin plant. (This had formerly been the Czechoslovak branch of the Philips firm.) Dr. LOM, an Institute employee about 26 years old, anti-Communist, headed this development. I do not know the results, but I do know that development in this field continued.

28. Projector bulbs were developed in the Institute in 1949. I do not know any other details.

Research Activities at the Institute

29. Preparation of insulation material to cover heating filaments of indirectly heated tubes:

The basic material was Al_2O_3, a fine powder of which the European commercial name was Alundum. Until 1950 this material was brought into Czechoslovakia from Eindhoven, the Netherlands, and starting in 1950 it was also imported from the US under another commercial name which I cannot remember. Al_2O_3 was diluted with ethyl alcohol and with an additional substance which I cannot remember. Two insulation processes were performed and the nature of the solution containing Al_2O_3 was different for each process. One process was cataphoresis and the other was a simple immersion process. The first instructions describing the preparation of these insulating materials were prepared in the first half of 1950 for the Tesla Hloubetin plant and the Tesla Roznov plant. These instructions were part of the specifications for the first miniature tube. /See paragraph 21/. Research was started on the preparation of Al_2O_3 during 1951 in order to avoid importing this material from abroad. I do not know the result of this research.

30. Preparation of emission material for cathodes of indirectly heated vacuum tubes:

The basic material was $BaCO_3$,$SrCO_3$. Originally Czechoslovakia imported ready-made cathodes for indirectly heated vacuum tubes from the Netherlands. Starting probably in 1949 Czechoslovakia imported $BaCO_3$ and $SrCO_3$ in powder form. These imports most probably came from the Netherlands. The chemical laboratories of the Tesla Hloubetin plant and the Tesla Roznov plant prepared the emission material from these imported materials. The emission material prepared in the Tesla plants was of a poor quality. The Institute used the experience of these two Tesla plants to produce its own emission material. The first instructions issued by the Institute for the preparation of the emission material was a part of the specifications for the first Czechoslovak miniature tube. These specifications were not satisfactory. They were not in sufficient detail and were in other respects not satisfactory for mass production. However, the research has continued and I believe that the quality of the emission material produced in Czechoslovakia has been much improved since that time. In addition to the preparation of the emission material the Institute started research in 1951 for the preparation of the $BaCO_3$ and $SrCO_3$ powders. I do not know the result of this research.

31. Preparation of insulation material to coat mica or ceramic plates supporting the internal system of vacuum tubes /Annex D, Sketch A, Pt. 7/:

The basic material was MgO. This insulation material was initially prepared by the chemical laboratories in the Tesla Hloubetin plant. The material was of poor quality. The first specifications for the preparation of MgO material were issued by the Institute and were made part of the specification of the first Czechoslovak miniature tube.

32. Preparation of insulation materials to be used in the production of picture tubes:

The development of picture tubes in the Institute necessarily involved preparation of insulation material for screens of the tubes and for covering the internal side of the glass envelope to prevent secondary emission of electrons. I do not know the details of this material. For the coating of the internal side of the envelope a carbon material was used, the exact nature of which is unknown to me. The development of phototubes involved the preparation of material to cover the internal side of the envelope with a mirror-like layer. The material was most probably made of cesium. I have no other details.

33. Preparation of zircon material to cover anodes of special vacuum tubes:

The first efforts to prepare zircon material to cover anodes of special tubes were made in 1946 and 1947 in the Tesla Hloubetin plant. The zircon powder used for that purpose was imported from abroad. The results proved unsatisfactory. It was planned in 1950 for the Institute to start research on the preparation of this material. I have no further details.

50X1 1. [redacted] Comment: For a report on the research activities of the
50X1 Institute [redacted] A later report will cover the subject of the Institute's department for setting up Czechoslovak standards for vacuum tubes.

50X1 2. [redacted] Comment: These figures are given as prior to the currency reform of June 1953.

50X1 3. [redacted] Comment: The description of this type of machine will be
50X1 given in [redacted] about the Tesla Roznov plant.

ANNEX:

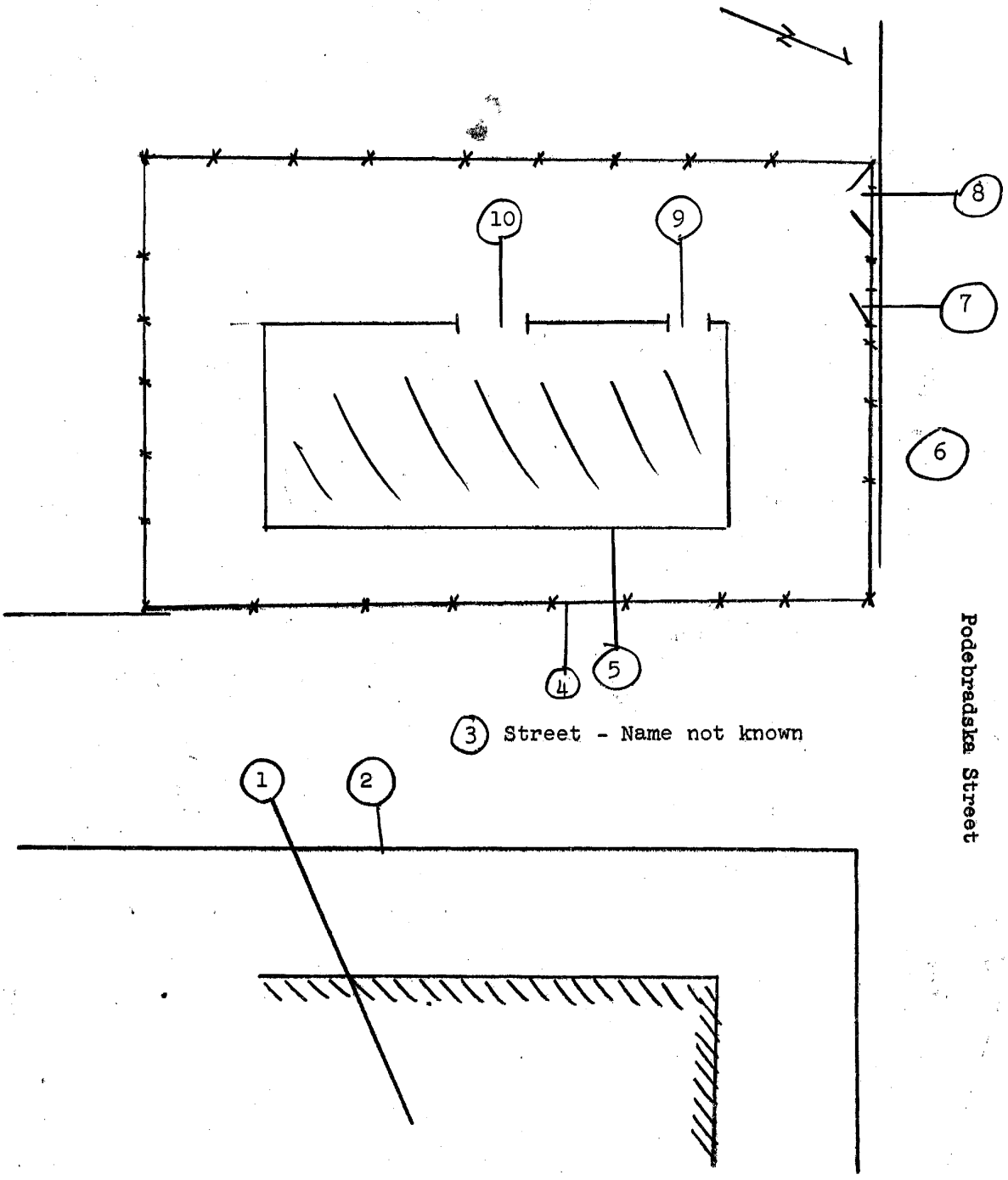
A. Podebradska Street Building, located at Podebradska Street # 184, Prague

B. Podebradska Street Building, Development Department

C. Nademlynska Street Building

D. Sketches of Czechoslovak Vacuum Tubes

Annex A. Podebradska Street Building, located at Podebradska Street # 184, Prague



Annex A (Cont'd)

LEGEND

Point # 1. Part of the buildings of the Tesla Julius Fucik Works.

2. Wall, two meters high, surrounding the area of Pt. 1.

3. Street

4. Fence, 2 - 2½ m. high, mesh wire on a one-half meter high concrete foundation, surrounding an area 20 x 30 m. in size.

5. Podebradska Street building of the Institute; gray stuccoed brick, two storied, with concrete low-pitched gable roof and rows of windows on both longer sides. I did not observe any antennas on the roof. The building was about two to four meters from the fence (Pt. 4). /For description of the interior see Annex B./

6. Podebradska Street

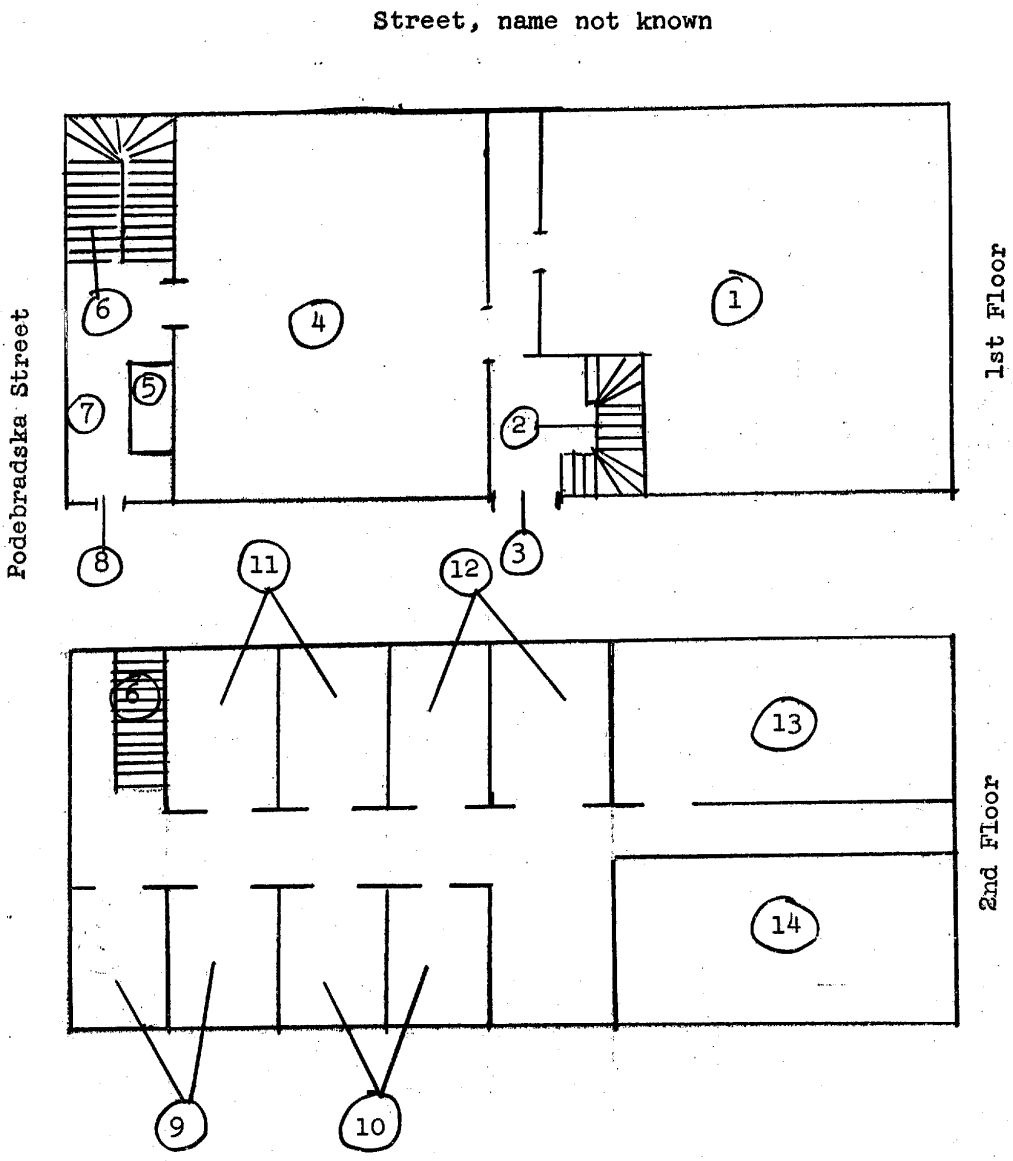
7. Entrance, single-winged, 1½ m. wide, not guarded, not locked during the day, opened by an electric device from the building at night.

8. Gate for vehicles, double-winged, three meters wide.

9. Side entrance, single-winged, 1.20 m. wide and 2.20 m. high, leading to guard room.

10. Main entrance; usually locked; most people used the side entrance (Pt. 9). The main entrance was double-winged, 2 - 2½ m. wide and 2.20 m. high.

Annex B. Podebradska Street Building, Development Department



Annex B (Cont'd)

LEGEND

First Floor

Point # 1. Production of parts and assembly hall

2. Stairway to second floor

3. Main Entrance (not used since 1952)

4. Production of samples (sealing and evacuating of tubes and other processes)

5. Guard post

6. Secondary stairway to second floor

7. Corridor

8. Secondary entrance used as main entrance

Second Floor

9. Standards Department

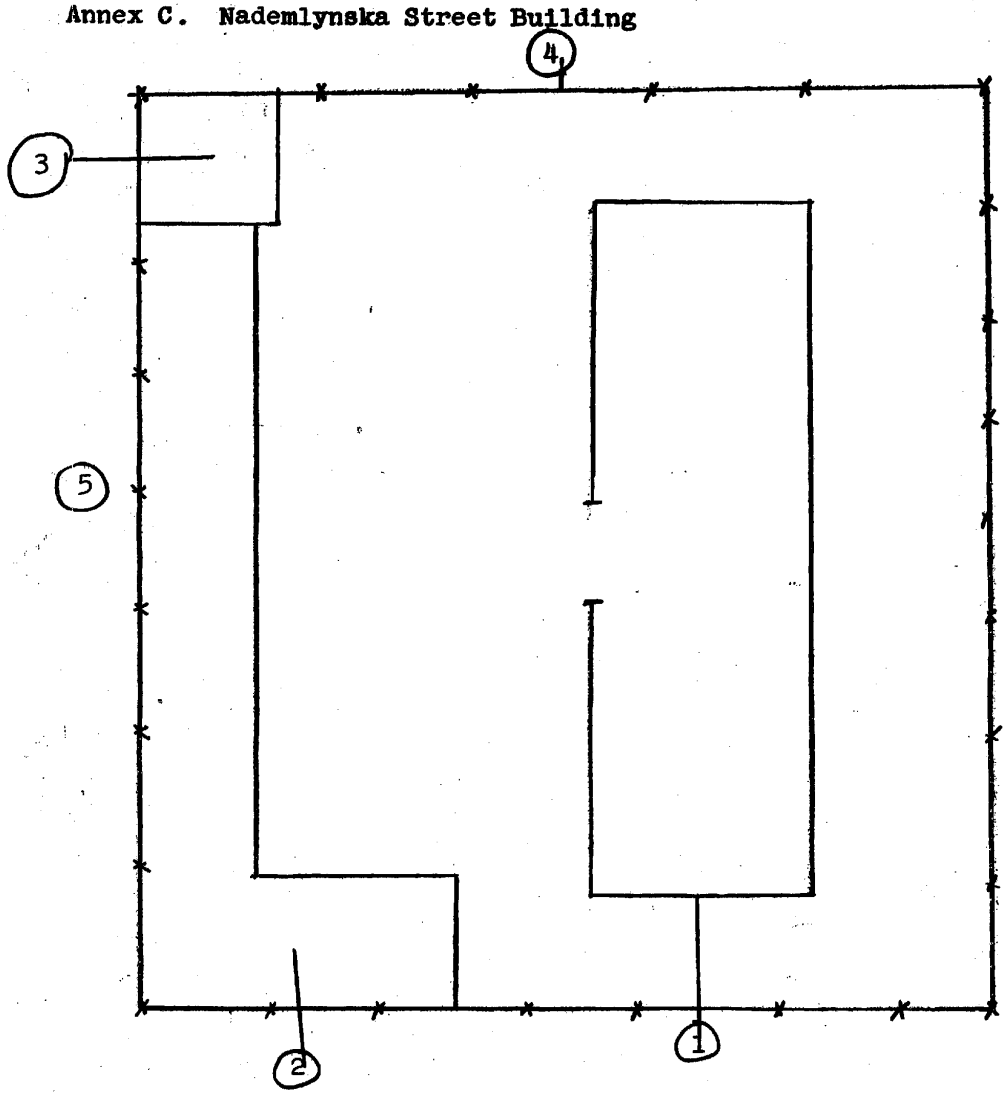
10.)
11.) Offices of the Development Department
12.)

13. Designing Department

14. Chemical Laboratory

NOTE: It is possible that the Standards Department, Designing Department, and Laboratories were transferred to the Nademlynska Street building in the autumn of 1952, as the Podebradska Street building was tending to be used solely for production of samples.

Annex C. Nademlynska Street Building



LEGEND

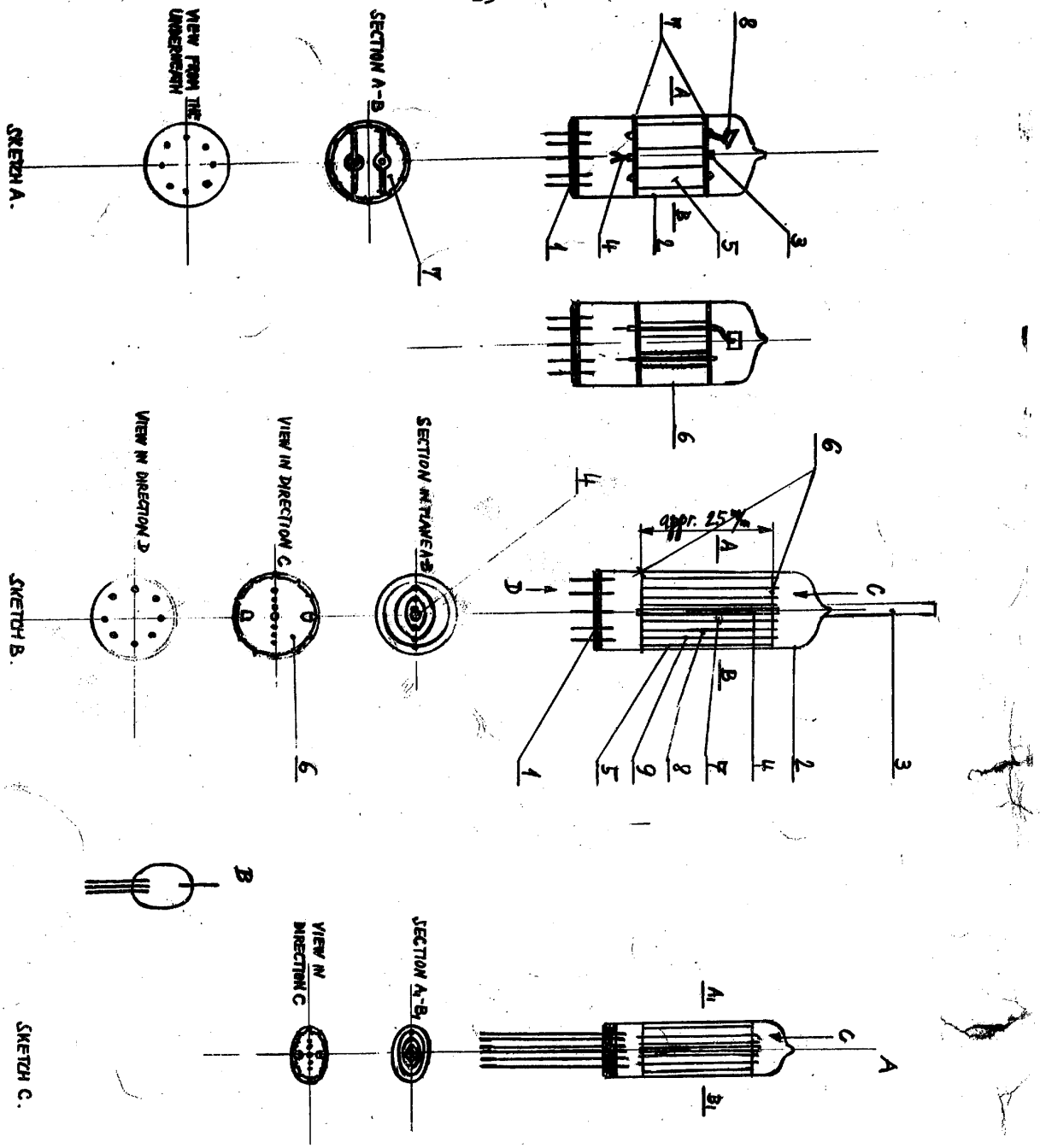
Point # 1. Main Building, three or four floors, 40 x 12 x 16 m. Administration offices and some laboratories were located in this building.

2. One-Floor Auxiliary Building (warehouse, etc.)

3. Gate House

4. Wire fence with concrete foundation

5. Boundary Area



Annex D. Sketches of Czechoslovak Vacuum Tubes

Annex D (Cont'd)

LEGEND to Sketch A, First Czechoslovak miniature, Scale 1:1

Point # 1. Glass die casting - base.

2. Envelope

3. Cathode K

4. Filament F

5. Anode

6. Cross section view through x-x.

7. Mica plates

8. Supporter for getter.

LEGEND to Sketch B, Miniature developed in 1950, Scale 1:1

Point # 1. Base (glass die casting) with eight sealed chromium iron (Cr - 25%, Fe - 75%) prongs. The prongs were about 0,8 mm. in diameter.

2. Lead glass envelope

3. Lead glass tube for evacuation of air and gases from the miniature tube.

4. Cathode. Nickel tubing (about 20% Co, about 80% Ni and a minimum amount of impurities). The cathode was coated with an emission layer of BaO.SrO. Prior to the manufacturing process this layer was $BaCO_3$. $SrCO_3$ which was reduced to the oxide upon evacuating the gases from the tube.

5. Anode. Nickel sheet tubing (sheet 0.1 - 0.125 mm. thick, tubing 12 - 13 mm. in diameter).

6. Two mica insulation plates (one on top and one on bottom), 0.2 to 0.3 mm. thick for support of the tube elements (anode, cathode and grids). The plates were round, their diameter equal to the inside diameter of the glass envelope.

7. First grid (closest to the cathode). Supporting wires made of Cu plus two percent Ag, 0.4 mm. in diameter, wound with Mo wire. Three or four wires were used for support.

8. Second grid) Ni plus two percent Mn supporting wires wound
9. Third grid) with Mo wire.

Nickel strips connected the electrodes with the prongs (not shown on sketch).

LEGEND to Sketch C, Scale 1:1

Figure A: Sub-miniature tube

Figure B: Sub-sub-miniature tube